New Hampshire Volunteer River Assessment Program

2004

COCHECO RIVER

WATER QUALITY REPORT

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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STATE OF NEW HAMPSHIRE

Volunteer River Assessment Program

2004

COCHECO RIVER

Water Quality Report

STATE OF NEW HAMPSHIRE
DEPARTMENT OF ENVIRONMENTAL SERVICES
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Cover Photograph: Cocheco River, Farmington

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The New Hampshire Department of Environmental Services (NHDES) -Volunteer River Assessment Program (VRAP) extends sincere thanks to the Cocheco River Watershed Coalition monitoring volunteers for their efforts during 2004. This report was created solely from the data collected by the volunteers listed below. Their time and dedication is an expression of their genuine concern for local water resources and has significantly contributed to our knowledge of river and stream water quality in New Hampshire.

2004 Cocheco River Volunteers

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1. INTRODUCTION

1.1. Purpose of Report

Each year NHDES prepares and distributes a water quality report for each volunteer group that is based solely on the water quality data collected by that volunteer group during a specific year. The reports summarize and interpret the data, particularly as they relate to New Hampshire surface water quality standards, and serve as a teaching tool and guidance document for future monitoring activities by the individual volunteer groups. The purpose of this report is to present the data collected by the Cocheco River VRAP volunteers in 2004.

1.2. Report Format

Each report includes the following:

- ✓ **Volunteers River Assessment Program (VRAP) Overview:** This section includes a discussion of the history of VRAP, the technical support, training and guidance provided by NHDES, and how data is transmitted to the volunteers and used in surface water quality assessments.

- ✓ **Water Quality Parameters Typically Selected for Monitoring**: This section includes a brief discussion of water quality parameters typically sampled by volunteers and their importance, as well as applicable state water quality criteria or levels of concern.

- ✓ **Monitoring Program Description**: A description of the volunteer group's monitoring program is provided in this section including monitoring objectives as well as a table and map showing sample station locations.

- ✓ **Results and Discussion:** Water quality data collected during the year are summarized on a parameter-by-parameter basis using (1) a summary table that includes the number of samples collected, data ranges, the number of samples meeting New Hampshire water quality standards, and the number of samples adequate for water quality assessments at each station, (2) a discussion of the data, (3) a list of applicable recommendations, and (4) a river graph showing the range of measured values at each station. Sample results reported as less than the detection limit were assumed equal to one-half the detection limit on the river graphs. This approach simplifies the understanding of the parameter of interest, and specifically helps one to visualize how the river or watershed is functioning from upstream to downstream. In addition, this format allows the reader to better understand potential pollution areas and target those areas for additional sampling or environmental enhancements. Where applicable, the river graph also shows New Hampshire surface water quality standards or levels of concern for comparison purposes.

- ✓ **Appendix – Data:** The appendix includes a spreadsheet showing the data results and additional information, such data results which do not meet New Hampshire surface water quality standards, and data that is unusable for assessment purposes due to quality control requirements.

2. VOLUNTEER RIVER ASSESSMENT PROGRAM OVERVIEW

2.1. Past, Present, and Future

In 1998, the New Hampshire Department of Environmental Services (DES) initiated the New Hampshire Volunteer River Assessment Program (VRAP) as a means of expanding public education of water resources in New Hampshire. VRAP promotes education and awareness of the importance of maintaining water quality in rivers and streams. VRAP was created in the wake of the success of the existing New Hampshire Volunteer Lake Assessment Program (VLAP), which provides educational and stewardship opportunities pertaining to lakes and ponds to New Hampshire's residents.

Today, VRAP continues to serve the public by providing water quality monitoring equipment, technical support, and educational programs. VRAP supports over a dozen volunteer groups on numerous rivers and watersheds throughout the state. These volunteer groups conduct water quality monitoring on an ongoing basis. The work of the VRAP volunteers increases the amount of river water quality information available to local, state and federal governments, which allows for effective financial resource allocation and watershed planning.

The intent of VRAP is to educate people of all ages and backgrounds about river and stream water quality, the threats to water quality posed by increasing population, development and industrialization, and the ways in which we can all work together to minimize these impacts.

2.2. Technical Support

VRAP lends and maintains water quality monitoring kits to volunteer groups throughout the state. The kits contain electronic meters and supplies for "in-the-field" measurements of water temperature, dissolved oxygen, pH, specific conductance (conductivity), and turbidity. These are the core parameters typically measured by volunteers. However, other water quality parameters such as nutrients, metals, and *E. coli* can also be studied by volunteer groups, although VRAP does not always provide funds to cover laboratory analysis costs. Thus, VRAP encourages volunteer groups to pursue other fundraising activities such as association membership fees, special events, in-kind services (non-monetary contributions from individuals and organizations), and grant writing.

VRAP typically recommends sampling every other week during the summer, and citizen-monitoring groups are encouraged to organize a long-term sampling program in order to begin to determine trends in river conditions. Each year volunteers arrange a sampling schedule and design in cooperation with the VRAP Coordinator. Project designs are created through a review and discussion of existing water quality information, such as known and perceived problem areas or locations of exceptional water quality. The interests, priorities, and resources of the partnership determine monitoring locations, parameters, and frequency.

Water quality measurements repeated over time create a picture of the fluctuating conditions in rivers and streams and help to determine where improvements, restoration or preservation may benefit the river and the communities it supports. Water quality results are also used to determine if a river is meeting surface water quality standards. Volunteer monitoring results, meeting DES Quality Assurance and Quality Control (QA/QC) requirements, supplement the efforts of DES to assess the condition of New Hampshire surface waters. The New Hampshire Surface Water Quality Regulations are available through the DES Public Information Center at www.des.state.nh.us/wmb/Env-Ws1700.pdf or (603) 271-1975.

2.3. Training and Guidance

Each VRAP volunteer must attend an annual training session to receive a demonstration of monitoring protocols and sampling techniques. Training sessions are an opportunity for volunteers to come together and receive an updated version of monitoring techniques. During the training, volunteers have a chance to practice using the VRAP equipment and may also receive instruction in the collection of samples for laboratory analysis. Training is accomplished in approximately three hours, after which volunteers are certified in the care, calibration, and use of the VRAP equipment.

VRAP groups conduct sampling according to a prearranged monitoring schedule and VRAP protocols. VRAP aims to visit volunteers during scheduled sampling events to verify that volunteers successfully follow the VRAP protocols. If necessary, volunteers are re-trained during the visit, and the group's monitoring coordinator is notified of the result of the verification visit. Volunteer organizations forward water quality results to the VRAP Coordinator for incorporation into an annual report and state water quality assessment activities.

2.4. Data Usage

2.4.1. Public Outreach/Water Quality Reports

All data collected by volunteers are summarized in water quality reports that are prepared and distributed after the conclusion of the sampling period (typically fall or winter). Each volunteer group receives copies of the report. The volunteers can use the reports and data as a means of understanding the details of water quality, guiding future sampling efforts, or determining restoration activities.

2.4.2. State Surface Water Quality Assessments

Along with data collected from other water quality programs, specifically the State Ambient River Monitoring Program, applicable volunteer data are used to support periodic DES surface water quality assessments. VRAP data are entered into NHDES's Environmental Monitoring Database and are ultimately uploaded to the Environmental Protection Agency's database, STORET. Assessment results and the methodology used to assess surface waters are published by DES every two years (i.e., Section 305(b) Water Quality Reports) as required by the federal Clean Water Act. The reader is encouraged to log on to the DES web page to review the assessment methodology and list of impaired waters http://www.des.state.nh.us/wmb/swqa/.

2.5. Quality Assurance/Quality Control

In order for VRAP data to be used in the assessment of New Hampshire's surface waters, the data must meet quality control guidelines as outlined in the VRAP Quality Assurance Project Plan (QAPP). The VRAP QAPP was approved by NHDES and reviewed by EPA in the summer of 2003. The QAPP is reviewed annually and is officially updated and approved every five years. The VRAP Quality Assurance/Quality Control (QA/QC) measures include a six-step approach to ensuring the accuracy of the equipment and consistency in sampling efforts.

- **Calibration**: All meters are calibrated before the first measurement and after the last one. Prior to each measurement, the pH and dissolved oxygen meters are calibrated.
- **Replicate Analysis**: A second measurement by each meter is taken from the original sample at one of the stations during the sampling day. The replicate analysis should not be conducted at the same station over and over again, but should be conducted at different stations throughout the monitoring season.
- **6.0 pH Standard**: A reading of the pH 6.0 buffer is recorded at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the 6.0 pH standard check should be conducted at different stations.
- **Zero Oxygen Standard**: A reading of a zero oxygen solution is recorded at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the zero oxygen standard check should be conducted at different stations.
- **DI Turbidity Blank**: A reading of the DI blank is recorded at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the blank check should be conducted at different stations.
- **Post-Calibration**: At the conclusion of each sampling day, all meters are calibrated.

2.5.1. Measurement Performance Criteria

Precision is calculated for field and laboratory measurements through measurement replicates (instrumental variability) and is calculated for each sampling day. The use of VRAP data for assessment purposes is contingent on compliance with a parameter-specific relative percent difference (RPD) as derived from equation 1, below. Any data exceeding the limits of the individual measures are disqualified from surface water quality assessments. All data that exceeds the limits defined by the VRAP QAPP are acknowledged in the data tables with an explanation of why the data was unusable. Table 2-1 shows typical parameters studied under VRAP and the associated quality control procedures.

(Equation 1)

$$RPD = \frac{|x_1 - x_2|}{\frac{x_1 + x_2}{2}} \times 100\ \%$$

where x_1 is the original sample and x_2 is the replicate sample

Table 2- 1. Field Analytical Quality Controls

Water Quality Parameter	QC Check	QC Acceptance Limit	Corrective Action	Person Responsible for Corrective Action	Data Quality Indicator
Temperature	Measurement replicate	± 0.2 ^{o}C	Repeat measurement	Volunteer Monitors or Program Manager	Precision
Dissolved Oxygen	Measurement replicate	± 2% of saturation, or ± 0.2 mg/L	Recalibrate instrument, repeat measurement	Volunteer Monitors or Program Manager	Precision
	Known buffer (zero oxygen solution)	<0.5 mg/L	Recalibrate instrument, repeat measurement	Volunteer Monitors or Program Manager	Relative accuracy
pH	Measurement replicate	± 0.1 std units	Recalibrate instrument, repeat measurement	Volunteer Monitors or Program Manager	Precision
	Known buffer (pH = 6.0)	± 0.1 standard units	Recalibrate instrument repeat measurement	Volunteer Monitors or Program Manager	Accuracy
Specific Conductance	Measurement replicate	± 30 µS/cm	Recalibrate instrument, repeat measurement	Volunteer Monitors or Program Manager	Precision
	Method blank	± 5.0 µS/cm	Recalibrate instrument, repeat measurement	Volunteer Monitors or Program Manager	Accuracy
Turbidity	Measurement replicate	± 0.1 NTU	Recalibrate instrument, repeat measurement	Volunteer Monitors or Program Manager	Precision
	Method blank	± 0.1 NTU	Recalibrate instrument, repeat measurement	Volunteer Monitors or Program Manager	Accuracy

3. WATER QUALITY PARAMETERS TYPICALLY MEASURED BY VRAP VOLUNTEERS

3.1. Temperature

Water temperature is one of the most important and commonly observed water quality parameters. Temperature influences the rate of many physical, chemical and biological processes in the aquatic environment. Each aquatic species has a range of temperature and other factors that best support its reproduction and the survival of offspring. Temperature can also impact aquatic life because of its influence on parameters such as ammonia as well as the concentration of dissolved oxygen in the water.

Temperature in Class B waters shall be in accordance with RSA 485-A:8, II which states in part "any stream temperature increase associated with the discharge of treated sewage, waste or cooling water, water diversions, or releases shall not be such as to appreciably interfere with the uses assigned to this class."

3.2. Dissolved Oxygen

Adequate oxygen dissolved in the water is crucial to the survival and successful reproduction of many aquatic species. Organisms such as fish use gills to transfer oxygen to their blood for vital processes that keep the fish active and healthy. Oxygen is dissolved into the water from the atmosphere, aided by wind and wave action where it tumbles over rocks and uneven stream beds. Aquatic plants and algae produce oxygen in the water, but this contribution is offset by respiration at night as well as by bacteria which utilize oxygen to decompose plants and other organic matter into smaller and smaller particles.

Oxygen concentrations in water are measured using a meter that produces readings for both milligrams per liter (mg/L) and percent (%) saturation of dissolved oxygen. For Class B waters, any single dissolved oxygen reading must be greater than 5 mg/L for the water to meet New Hampshire water quality standards. This means that in every liter of water there must be at least five milligrams of dissolved oxygen available for ecosystem processes.

More than one measurement of oxygen saturation taken in a twenty-four hour period can be averaged to compare to the standards. Class B waters must have a dissolved oxygen content of not less than 75% of saturation, based on a daily average. The concentration of dissolved oxygen is dependent on many factors including temperature and sunlight, and tends to fluctuate throughout the day. Saturation values are averaged because a reading taken in the morning may be low due to respiration, while a measurement that afternoon may show that the percent saturation has recovered to acceptable levels. Water can become saturated with more than 100% dissolved oxygen. It should be noted that other dissolved oxygen requirements in the New Hampshire Surface Water Quality

Regulations (Env-Ws 1700) pertain to cold water fish spawning areas, impoundments (dams), and reservoirs.

3.3. pH

pH is a measure of hydrogen ion activity in water. The lower the pH, the more acidic the solution due to higher concentrations of hydrogen ions. A high pH is indicative of an alkaline or basic environment. pH is measured on a logarithmic scale of 0 to 14. NH rivers typically fall within the range of pH values from 6 to 8. Most aquatic species need a pH of between 5 and 9. pH also affects the toxicity of other aquatic compounds such as ammonia and certain metals.

New Hampshire Surface Water Quality Regulations (Env-Ws 1700) state that pH shall be between 6.5 and 8, unless naturally occurring. Readings that fall outside this range may be due to natural conditions such as the influence of wetlands near the sample station or because of the soils and bedrock in the area. Tannic and humic acids released to the water by decaying plants, for example, can create more acidic waters in areas influenced by wetlands. Low pH can also be due to atmospheric deposition of chemicals emitted by sources such as fossil fuel power plants and car emissions. When it rains, the chemicals in the atmosphere can lower the pH of the rain (commonly referred to as “acid rain”), which can, in turn, lower the pH of the river or stream. Acid rain typically has a pH of 3.5 to 5.5.

3.4. Specific Conductance

Specific conductance (informally termed conductivity) is the numerical expression of the ability of water to carry an electric current, and is a measure of the free ion content in the water. Water contains ions (charged particles) which can come from natural sources such as bedrock, or be introduced by human activity. The free ions carry an electrical current. Conductivity can be used to indicate the presence of chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, iron, and aluminum ions.

There is no numeric standard for conductivity because levels naturally vary a great deal according to the geology of an area. Conductivity readings are useful for screening an area to determine potential pollution sources.

3.5. Turbidity

Turbidity is an indicator of the amount of suspended material in the water, such as clay, silt, algae, suspended sediment, and decaying plant material. A high degree of turbidity can scatter the passage of light through the water, and inhibit light from reaching important areas. Clean waters are generally associated with low turbidity, but there is a high degree of natural variability involved. Rain events often contribute turbidity to surface waters by flushing sediment, organic matter and other materials from the surrounding landscape into surface waters. According to New Hampshire’s Surface Water Quality

Regulations (Env-Ws 1700), Class B waters shall not exceed naturally occurring conditions by more than 10 Nephelometric Turbidity Units (NTU).

3.6. Bacteria

Organisms causing infections or disease (pathogens) are often excreted in the fecal material of humans and other warm-blooded animals. *Escherichia coli* (*E. coli*) bacteria is not considered pathogenic. *E. coli* is, however, almost universally found in the intestinal tracts of humans and warm blooded animals and is relatively easy and inexpensive to measure. For these reasons *E. coli* is used as an indicator of fecal pollution and the possible presence of pathogenic organisms.

In fresh water, *E. coli* concentrations help determine if the water is safe for recreational uses such as swimming. According to New Hampshire's surface water quality standards, Class B waters shall contain not more than either a geometric mean based on at least three samples obtained over a sixty-day period of 126 *E. coli* per one hundred milliliters (CTS/100mL), or greater than 406 *E. coli* CTS/100mL in any one sample.

3.7. Total Phosphorus

Phosphorus is a nutrient that is essential to plants and animals, however, in excess amounts it can cause rapid increases in the biological activity in water. This may disrupt the ecological integrity of streams and rivers.

Phosphate is the form of phosphorus that is readily available for use by aquatic plants. Phosphate is usually the limiting nutrient in freshwater streams, which means relatively small amounts of phosphate can have a large impact on the biological activity in the water. Excess phosphorus can trigger nuisance algal blooms and aquatic plant growth, which can decrease oxygen levels and the attractiveness of waters for recreational purposes.

Phosphorus can be an indicator of sewage, animal manure, fertilizer, erosion, and other types of contamination. There is no numeric surface water quality standard for phosphorus due to the high degree of natural variability and the difficulty of pinpointing the exact source. However 0.05 mg/L total phosphorus is typically used as a level of concern, which means DES pays particular attention to readings above this level.

3.8. Metals

Depending on the metal concentration, its form (dissolved or particulate) and the hardness of the water, trace metals can be toxic to aquatic life. Metals in dissolved form are generally more toxic than metals in the particulate form. The dissolved metal concentration is dependent on the pH of the water, as well as the presence of solids and organic matter that can bind with the metal to render it less toxic. Hardness is primarily a measure of the calcium and magnesium ion concentrations in water, expressed as calcium carbonate. The hardness concentration affects the toxicity of certain metals. Numeric criteria for metals may be found in New Hampshire's Surface Water Quality Regulations (Env-Ws 1700).

4. MONITORING PROGRAM DESCRIPTION

The Cocheco River Watershed Coalition became interested in exploring water quality in the river system further after preliminary water quality investigations in 1998 with DES Watershed Assistance staff. The Strafford Regional Planning Commission submitted a Local Initiative Program grant application to DES and was awarded funding to support a project coordinator and coverage for sampling in addition to the VRAP baseline parameters. The City of Rochester Public Works Department donates in-kind services including analysis for *E. coli* bacteria and an extremely valuable municipal partnership. The Volunteer River Assessment Program has provided field training, equipment, and technical assistance.

This effort provides water quality data from the Cocheco River watershed relative to surface water quality standards. In addition, the ongoing effort allows for an understanding of the river's dynamics, or variations on a station-by-station and year-to-year basis. The data can also serve as a baseline from which to determine any water pollution problems in the river and/or watershed.

Fourteen sites along the mainstem of the Cocheco River were monitored in 2004 from its upper limits in Farmington to Dover. Additional monitoring was done at tributary stations on the Ela River, Mad River, and Dames Brook. Sampling station descriptions are provided in Table 4-1 and locations are shown on the foldout map on the following page.

Table 4-1. Sampling stations for the Cocheco River, NHDES VRAP, 2004

Station ID	Location	Town/City	Elevation*
28-CCH	Old Bay Road Bridge	Farmington	400
27-CCH	Spring Street Bridge	Farmington	400
26-CCH	Central St. Bridge	Farmington	300
25-CCH	South Main Street, Route 153	Farmington	300
23-CCH	Watson Corner Rd. Bridge	Farmington	300
22U-CCH	Pike Industries	Farmington	300
22-CCH	Little Falls Bridge Rd.	Rochester	300
21-CCH	Rte. 202A Bridge	Rochester	200
19-CCH	Rte. 125 Bridge	Rochester	200
18-CCH	Maple Street Bridge	Rochester	200
12-CCH	Strafford County Farm	Dover	100
11-CCH	Watson Rd. Bridge	Dover	100
10-CCH	Whittier St. Bridge	Dover	100
07-CCH	Central Avenue Bridge	Dover	0
04-ELA	Ela River, Spring Street Bridge	Farmington	300
03-MAR	Mad River, River St. Bridge	Farmington	500
02-MAR	Mad River, Rte. 11 Bridge	Farmington	400
01-MAR	Mad River, Tappen St. Bridge	Farmington	300
02-DMS	Dames Brook, Upstream of conf. w/ Kicking Horse Brook	Farmington	300
01-DMS	Dames Brook, Rte. 75 Bridge	Farmington	300

*Elevations have been rounded off to 100-foot increments for purposes of calibrating the dissolved oxygen meter.

5. RESULTS AND DISCUSSION

5.1. Dissolved Oxygen

5.1.1. Results and Discussion

Between one and five measurements were taken in the field for dissolved oxygen concentration at 14 stations on the mainstem of the Cocheco River from Farmington to Dover and one on the Mad River in Farmington [Table 5-1]. Of the 52 measurements taken, 44 met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2006 surface water quality report to the Environmental Protection Agency.

The Class B New Hampshire surface water quality standard for dissolved oxygen includes a minimum concentration of 5.0 mg/L **and** a minimum daily average of 75 % of saturation. In other words, there are criteria for both concentration and saturation that must be met before the river can be assessed as meeting dissolved oxygen standards.

Table 5-1. Dissolved Oxygen Data Summary, Cocheco River 2004, VRAP

Station ID	Samples Collected	Data Range (mg/l)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2006 NH Surface Water Quality Assessment
28-CCH	3	6.95 - 8.53	0	2[a]
27-CCH	3	9.02 - 9.59	0	2[a]
26-CCH	3	9.04 - 9.29	0	2[a]
01-MAR	1	9.36	0	1
25-CCH	1	8.87	0	1
23-CCH	4	7.91 - 9.77	0	3[a]
22U-CCH	4	6.54 - 8.65	0	3[a]
22-CCH	4	7.33 - 8.28	0	3[b]
21-CCH	4	6.44 - 8.35	0	3[b]
19-CCH	4	7.92 - 9.15	0	3[b]
18-CCH	1	7.96	0	1
12-CCH	5	7.2 - 8.56	0	5
11-CCH	5	7.64 - 8.38	0	5
10-CCH	5	7.53 - 9.08	0	5
07-CCH	5	6.64 - 8.69	0	5
Total Number of Useable Samples for 2006 NH Surface Water Quality Assessment				**44**

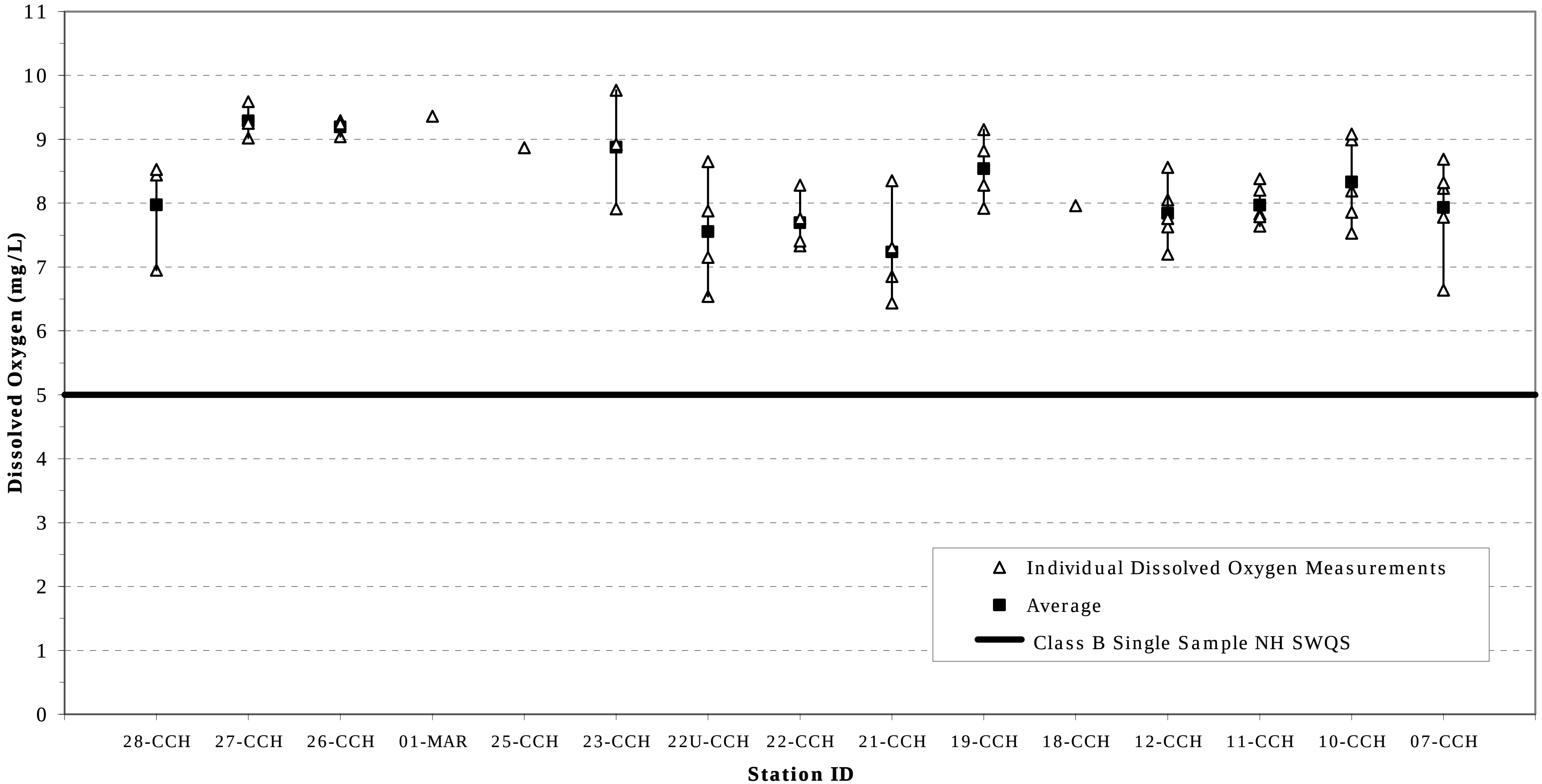
[a]Relative % differences of replicate exceeded standard in QAPP on 9/3/04
[b]Relative % differences of replicate exceeded standard in QAPP on 7/7/04

Dissolved oxygen concentration levels were above state standards on all occasions and at all stations (Figure 5-1). The average concentration of dissolved oxygen was consistently above the Class B standard at all stations ranging from 7.2 mg/L to 9.3 mg/L. Levels of dissolved oxygen sustained above the standards are considered adequate for wildlife populations and other desirable water quality conditions.

5.1.2. Recommendations

- Continue sampling at all stations to develop a long-term data set to better understand trends as time goes on.
- If possible, take measurements between 5:00 a.m. and 10:00 a.m., which is when dissolved oxygen is usually the lowest, and between 2:00 p.m. and 7:00 p.m. when dissolved oxygen is usually the highest.
- Incorporate the use of submersible meters to automatically record dissolved oxygen saturation levels during a period of several days. This could be done by using a Hydrolab® DataSonde 4a multiprobe, which is an instrument that can collect data at specific time intervals (e.g., every 15 minutes). The instrument can be put in the stream and left alone for a period of several days. The use of these instruments is dependent upon availability, and requires coordination with DES.

Figure 5-1. Dissolved Oxygen Statistics for the Cocheco River June 28 - September 16, 2004, NHDES VRAP



5.2. pH

5.2.1. Results and Discussion

Between one and five measurements were taken in the field for pH at 13 stations on the mainstem of the Cocheco River from Farmington to Dover and one on the Mad River in Farmington [Table 5-2]. Of the 44 measurements taken, 35 met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2006 surface water quality report to the Environmental Protection Agency.

The Class B New Hampshire surface water quality standard for pH is 6.5 - 8.0, unless naturally occurring.

Table 5-2. pH Data Summary, Cocheco River 2004, VRAP

Station ID	Samples Collected	Data Range (standard units)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2006 NH Surface Water Quality Assessment
28-CCH	2	6.27 - 6.48	1	2
27-CCH	2	6.96 - 7.25	0	2
26-CCH	2	6.68 - 7.09	0	2
01-MAR	1	5.91	1	1
25-CCH	1	6.29	1	1
23-CCH	3	5.79 - 6.62	2	2[a]
22U-CCH	3	5.8 - 6.06	3	2[a]
22-CCH	4	6.16 - 6.58	2	3[b]
21-CCH	4	5.68 - 6.41	3	3[b]
19-CCH	3	6.41 - 6.95	1	2[b]
12-CCH	5	6.42 - 6.86	3	4[c]
11-CCH	4	5.48 - 6.85	2	3[c]
10-CCH	5	6.42 - 6.69	1	4[d]
07-CCH	5	6.35 - 7.10	1	4[d]
Total Number of Useable Samples for 2006 NH Surface Water Quality Assessment				**35**

[a] 7/9/04 Replicate > .2 pH units from sample
[b] 7/7/04 Replicate > .2 pH units from sample
[c] 8/9/04 Replicate > .2 pH units from sample
[d] 9/5/04 Replicate > .2 pH units from sample

A majority of the pH measurements on the Cocheco River were outside of the range of the New Hampshire surface water quality standard (Figure 5-2). This is likely the result of natural conditions such as the soils, geology, or the presence of wetlands in the area. It should be noted that rain and snow falling in New Hampshire is relatively acidic, which can also affect pH levels.

5.2.2. Recommendations

- Continue sampling at all stations; this will help to build a long-term data set to better understand trends as time goes on.
- Consider sampling for pH in some of the tributaries and wetland areas that are influencing the pH of stations with measurements below state standards. Site conditions are considered along with pH measurements because of the narrative portion of the pH standard. RSA 485-A:8 states that pH of Class B waters *shall be between 6.5 and 8.0, except when due to natural causes*. Wetlands can lower the pH of a river naturally by releasing tannic and humic acids from decaying plant material. If the sampling location is influenced by wetlands or other natural conditions, then the low pH measurements are not considered a violation of water quality standards. It is important to note that the New Hampshire water quality standard for pH is fairly conservative, thus pH levels slightly below the standard are not necessarily harmful to aquatic life. In this case, additional information about factors influencing pH levels is needed.

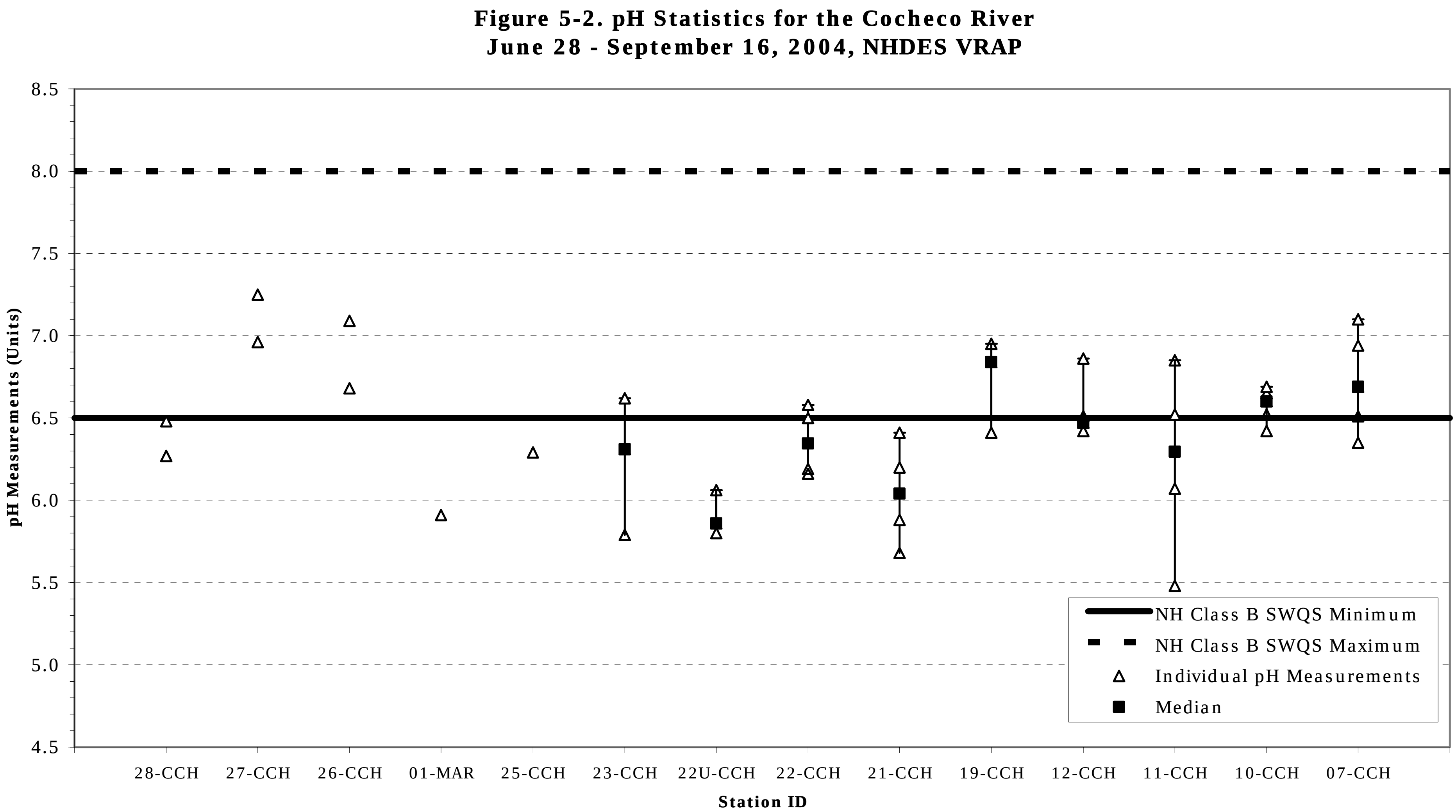


Figure 5-2. pH Statistics for the Cocheco River
June 28 - September 16, 2004, NHDES VRAP
pH Measurements (Units)
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
28-CCH
27-CCH
26-CCH
01-MAR
25-CCH
23-CCH
22U-CCH
22-CCH
21-CCH
19-CCH
12-CCH
11-CCH
10-CCH
07-CCH
Station ID
NH Class B SWQS Minimum
NH Class B SWQS Maximum
Individual pH Measurements
Median

5.3. Turbidity

5.3.1. Results and Discussion

Between one and five measurements were taken in the field for turbidity at 14 stations on the mainstem of the Cocheco River from Farmington to Dover and one on the Mad River in Farmington [Table 5-3]. Of the 52 measurements taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2006 surface water quality report to the Environmental Protection Agency. The Class B New Hampshire surface water quality standard for turbidity is less than 10 NTU above background.

Table 5-3 Turbidity Data Summary for the Cocheco River 2004, VRAP

Station ID	Samples Collected	Data Range (NTU)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2006 NH Surface Water Quality Assessment
28-CCH	3	1.11 - 1.86	0	3
27-CCH	3	0.77 - 1.20	0	3
26-CCH	3	1.60 - 1.91	0	3
01-MAR	1	0.6	0	1
25-CCH	1	1.9	0	1
23-CCH	4	1.37 - 5.60	0	4
22U-CCH	4	2.10 - 9.50	0	4
22-CCH	4	2.01 - 3.10	0	4
21-CCH	4	2.11 - 4.40	0	4
19-CCH	4	2.95 - 4.80	0	4
18-CCH	1	5.82	0	1
12-CCH	5	2.91 - 4.90	0	5
11-CCH	5	3.02 - 5.10	0	5
10-CCH	5	2.03 - 4.00	0	5
07-CCH	5	3.20 - 13.5	0	5
Total Number of Useable Samples for 2006 NH Surface Water Quality Assessment				**52**

Turbidity levels were low on all occasions and at all stations with the average ranging from 1.0 NTU to 5.8 NTU (Figure 5-3). Although clean waters are associated with low turbidity there is a high degree of natural variability involved. Precipitation often contributes to increased turbidity by flushing sediment, organic matter and other materials from the surrounding landscape into surface waters. However, human activities such as removal of vegetation near surface waters and disruption of nearby soils can lead to dramatic increases in turbidity levels.

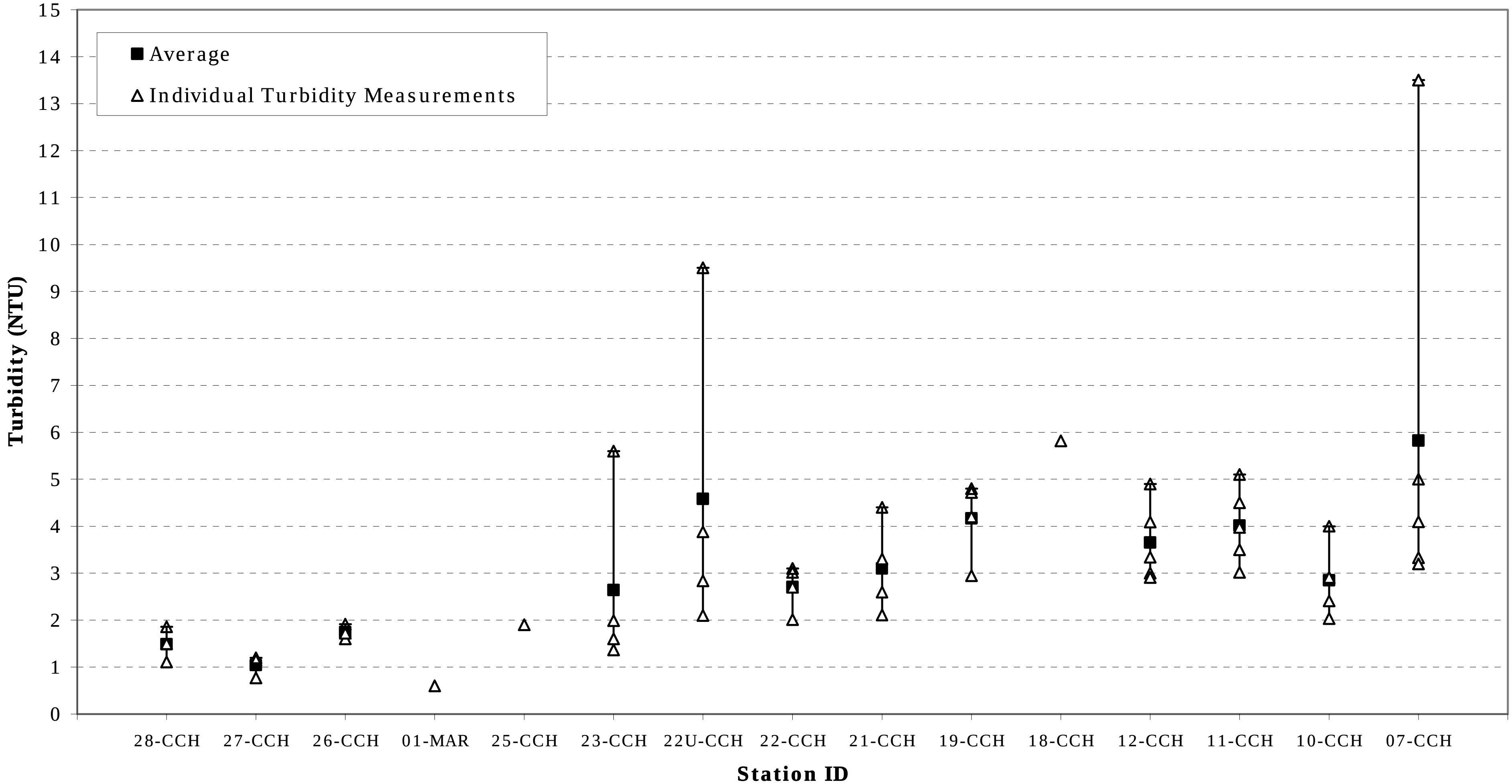
In general it is typical to see a rise in turbidity in more developed areas due to increased runoff. Figure 5-3 shows a slight increase in turbidity averages as one moves downstream towards the more developed areas in Rochester and Dover.

Turbidity levels during 2004 will be a useful indicator of the typical background conditions of the river.

5.3.2. Recommendations

- Continue sampling at all stations as this will help to build a long-term data set to better understand trends as time goes on.
- Collect samples during wet weather; this will help us to understand how the river responds to runoff and sedimentation.
- If a higher than normal turbidity measurement occurs, volunteers can investigate further by moving upstream and taking additional measurements. This will facilitate isolating the location of the cause of the elevated turbidity levels. In addition, take good field notes and photographs. If human activity is suspected or verified as the source of elevated turbidity levels volunteers should contact the VRAP coordinator so NHDES can further investigate.

Figure 5-3. Turbidity Statistics for the Cocheco River June 28 - September 16, 2004, NHDES VRAP



5.4. Specific Conductance

5.4.1. Results and Discussion

Between one and seven measurements were taken in the field for specific conductance at 14 stations on the mainstem of the Cocheco River from Farmington to Dover and one on the Mad River in Farmington [Table 5-4]. Of the 76 measurements taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2006 surface water quality report to the Environmental Protection Agency. New Hampshire surface water quality standards do not contain numeric limits for specific conductance.

Table 5-3 Specific Conductance Data Summary for the Cocheco River 2004, VRAP

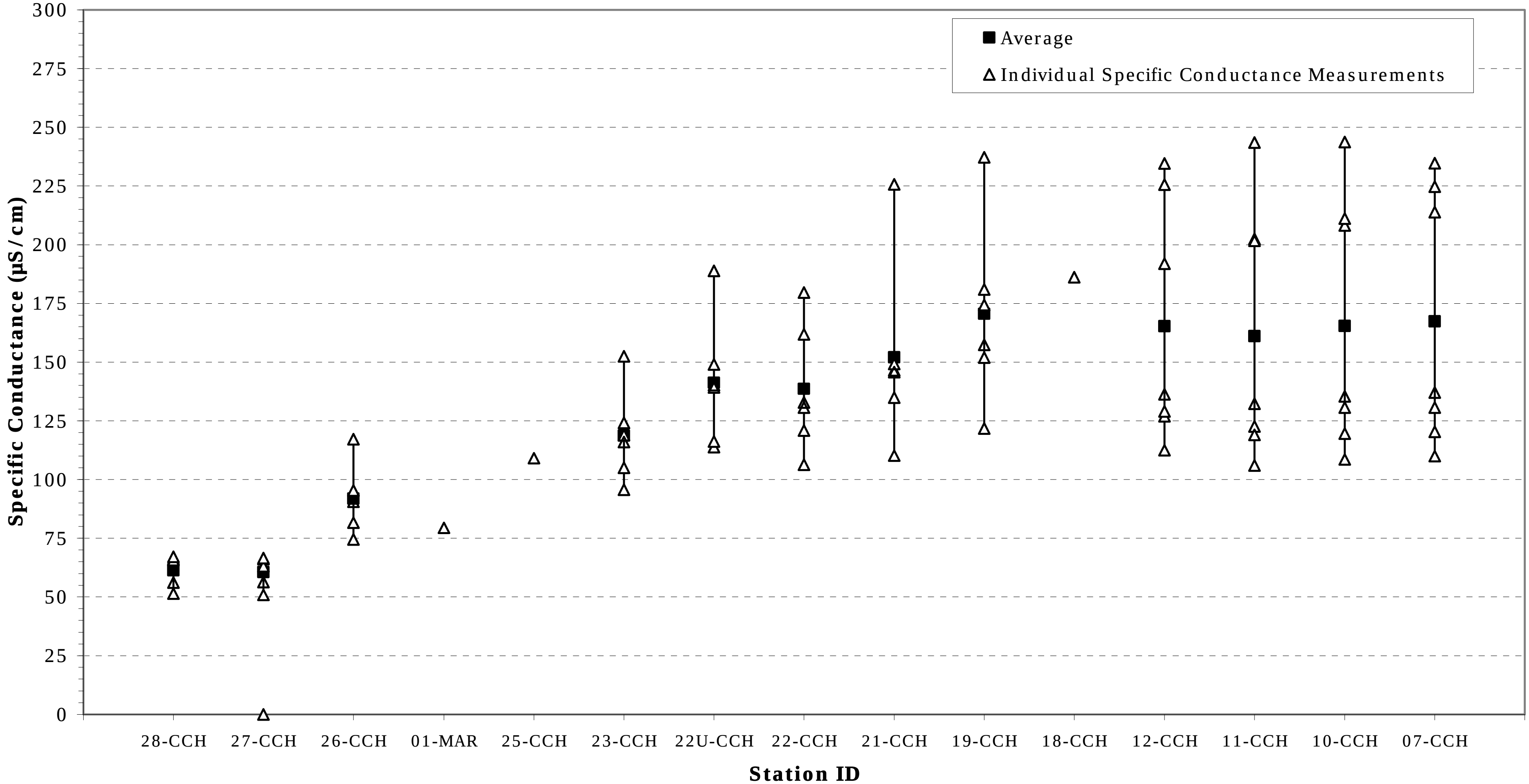
Station ID	Samples Collected	Data Range (µS/cm)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2006 NH Surface Water Quality Assessment
28-CCH	5	51.4 - 67.1	Not Applicable	5
27-CCH	5	50.9 - 66.6	N/A	5
26-CCH	5	74.5 - 117.2	N/A	5
01-MAR	1	79.4	N/A	1
25-CCH	1	109.1	N/A	1
23-CCH	6	95.7 - 152.5	N/A	6
22U-CCH	6	113.9 - 188.8	N/A	6
22-CCH	6	106.3 - 179.6	N/A	6
21-CCH	6	110.2 - 225.6	N/A	6
19-CCH	6	121.7 - 237.2	N/A	6
18-CCH	1	186.2	N/A	1
12-CCH	7	112.5 - 234.6	N/A	7
11-CCH	7	105.9 - 243.5	N/A	7
10-CCH	7	108.5 - 243.7	N/A	7
07-CCH	7	110.0 - 234.7	N/A	7
Total Number of Useable Samples for 2006 NH Surface Water Quality Assessment				**76**

Specific conductance levels were variable along the entire reach of the river with the average ranging from 61 µs/cm (upstream of Farmington) to 157 µs/cm (just downstream of downtown Rochester) (Figure 5-4). The influence of urbanization on specific conductance is apparent by the increased levels from the more rural upstream areas to the more developed areas in Dover and Rochester. Anions (negatively charged elements such as chloride) and cations (positively charged elements such as calcium) are typically found in rivers flowing through urbanized areas.

5.4.2. Recommendations

- Continue sampling at all stations as this will help to build a long-term data set to better understand trends as time goes on.

Figure 5-4. Specific Conductance Statistics for the Cocheco River
June 28 - September 16, 2004, NHDES VRAP



5.5. Bacteria/*Escherichia coli*

5.5.1. Results and Discussion

Between one and four measurements were taken in the field for *Escherichia coli* (*E. coli*) at 13 stations on the mainstem of the Cocheco River from Farmington to Dover (Table 5-5). Between one and three measurements were taken at six tributary stations on the Mad River, Ela River, and Dames Brook in Farmington. Of the 54 measurements taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2006 surface water quality report to the Environmental Protection Agency. Class B NH surface water quality standards for *E.coli* are as follows:

> <406 cts/100 ml, based on any single sample, or
> <126 cts/100 ml, based on a geometric mean calculated from three samples collected within a 60-day period.

Table 5-5 *E. coli* Data Summary for the Cocheco River 2004, VRAP

Station ID	Samples Collected	Data Range (cts/100ml)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2006 NH Surface Water Quality Assessment
28-CCH	2	30 - 40	0	2
27-CCH	3	10 - 120	0	3
26-CCH	4	50 - 110	0	4
04-ELA	1	10	0	1
03-MAR	1	20	0	1
02-MAR	1	10	0	1
01-MAR	3	200 - 590	1	3
02-DMS	1	0	0	1
01-DMS	1	70	0	1
23-CCH	4	70 - 250	0	4
22U-CCH	4	40 - 300	0	4
22-CCH	4	30 - 150	0	4
21-CCH	4	10 - 460	1	4
19-CCH	4	30 - 380	0	4
18-CCH	1	90	0	1
12-CCH	4	20 - 240	0	4
11-CCH	4	20 - 220	0	4
10-CCH	4	40 - 150	0	4
07-CCH	4	60 - 190	0	4
Total Number of Useable Samples for 2006 NH Surface Water Quality Assessment				**54**

Two stations tested for *E.coli* had single sample levels which exceeded the New Hampshire surface water quality standard (Figure 5-5). In order for a geometric mean to be computed three samples must be collected within a 60-day period. As Table 5-6 indicates three of the ten stations where a geometric mean could be calculated violated the standard of <126 cts/100 ml.

Several factors can contribute to elevated *E. coli* levels, including, but not limited to rain storms, low river flows, the presence of wildlife (e.g., birds), and the presence of septic systems along the river.

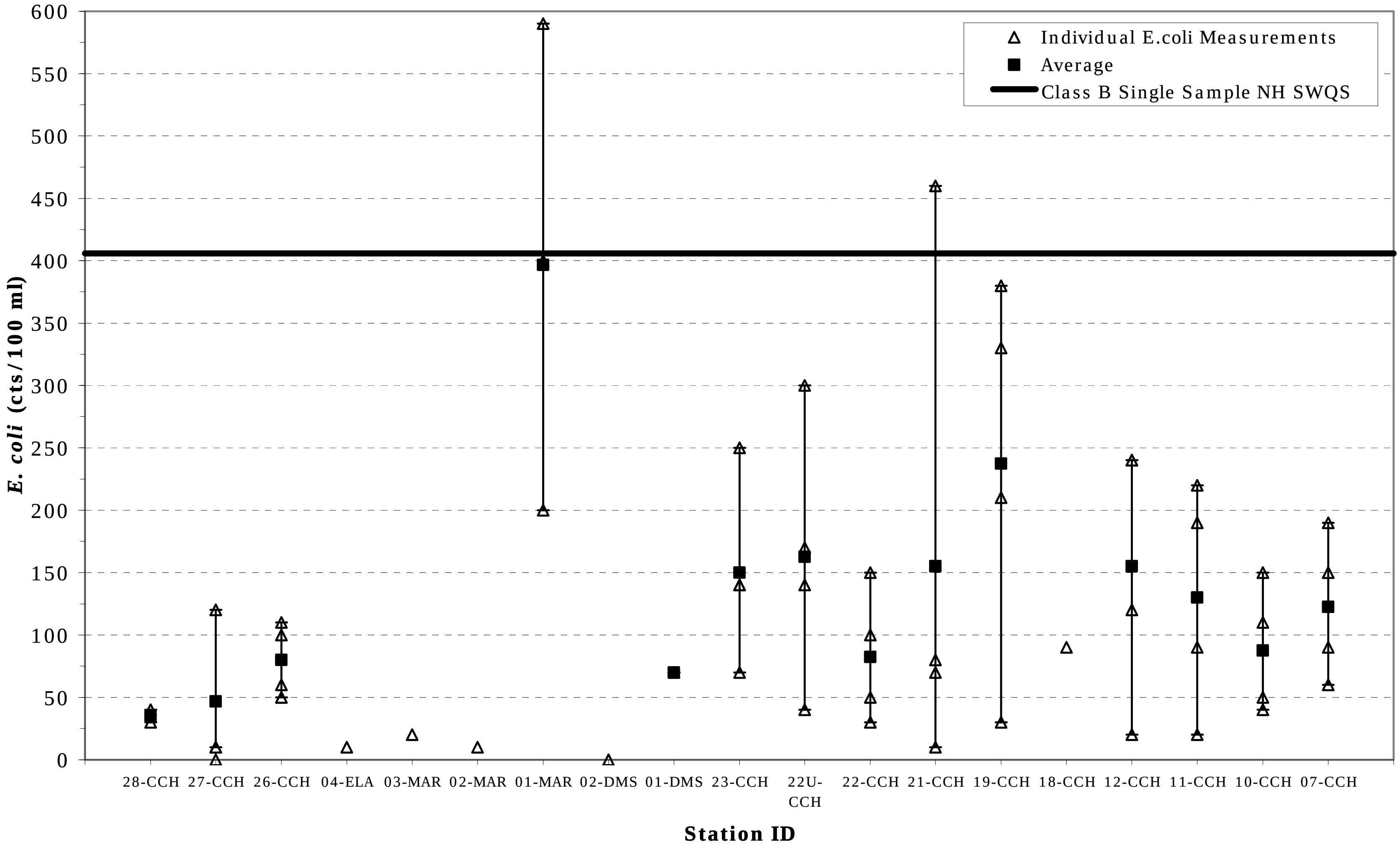
Table 5-6 Geometric means for *E. coli* data, Cocheco River 2004, VRAP

Station ID	Geometric Mean 6/14/04 - 8/9/04	Geometric Means Not Meeting NH Class B Standards
26-CCH	82	0
23-CCH	135	1
22U-CCH	127	1
22-CCH	53	0
21-CCH	69	0
19-CCH	156	1
12-CCH	83	0
11-CCH	73	0
10-CCH	60	0
07-CCH	93	0

5.5.2. Recommendations

- Continue collecting three samples within a 60-day period during the summer to allow for determination of geometric means.
- Continue to document river conditions and station characteristics (including the presence of wildlife in the area during sampling).
- At stations with particularly high bacteria levels volunteers can investigate further by moving upstream and taking additional measurements. This will facilitate isolating the location of the cause of the elevated bacteria levels. Those sampling should also look for any potential sources of bacteria such as emission pipes and failed septic systems.

Figure 5-5. *Escherichia coli* Statistics for the Cocheco River
June 14 - September 27, 2004, NHDES VRAP



5.6. Total Phosphorus

5.6.1. Results and Discussion

One or two samples were collected for total phosphorous at 13 stations on the mainstem of the Cocheco River from Farmington to Dover (Table 5-7). All measurements met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2004 surface water quality report to the Environmental Protection Agency. A numeric Class B NH surface water quality standard does not exist for total phosphorus. However, a total phosphorus concentration of 0.05 mg/L is used by NHDES as a level of concern and the agency pays particular attention to results above this level.

Table 5-7 Total Phosphorous Data Summary for the Cocheco River 2004, VRAP

Station ID	Samples Collected	Data Range (mg/L)	Acceptable Samples Exceeding NHDES Level of Concern	Number of Usable Samples for 2006 NH Surface Water Quality Assessment
28-CCH	1	0.010 - 0.010	0	1
27-CCH	2	0.010 - 0.014	0	2
26-CCH	2	0.011 - 0.015	0	2
23-CCH	2	0.031 - 0.033	0	2
22U-CCH	2	0.027 - 0.031	0	2
22-CCH	2	0.032 - 0.035	0	2
21-CCH	2	0.024 - 0.029	0	2
19-CCH	2	0.025 - 0.026	0	2
18-CCH	1	0.036 - 0.036	0	1
12-CCH	2	0.053 - 0.130	2	2
11-CCH	2	0.051 - 0.109	2	2
10-CCH	2	0.055 - 0.097	2	2
07-CCH	2	0.063 - 0.089	2	2
Total Number of Useable Samples for 2006 NH Surface Water Quality Assessment				**24**

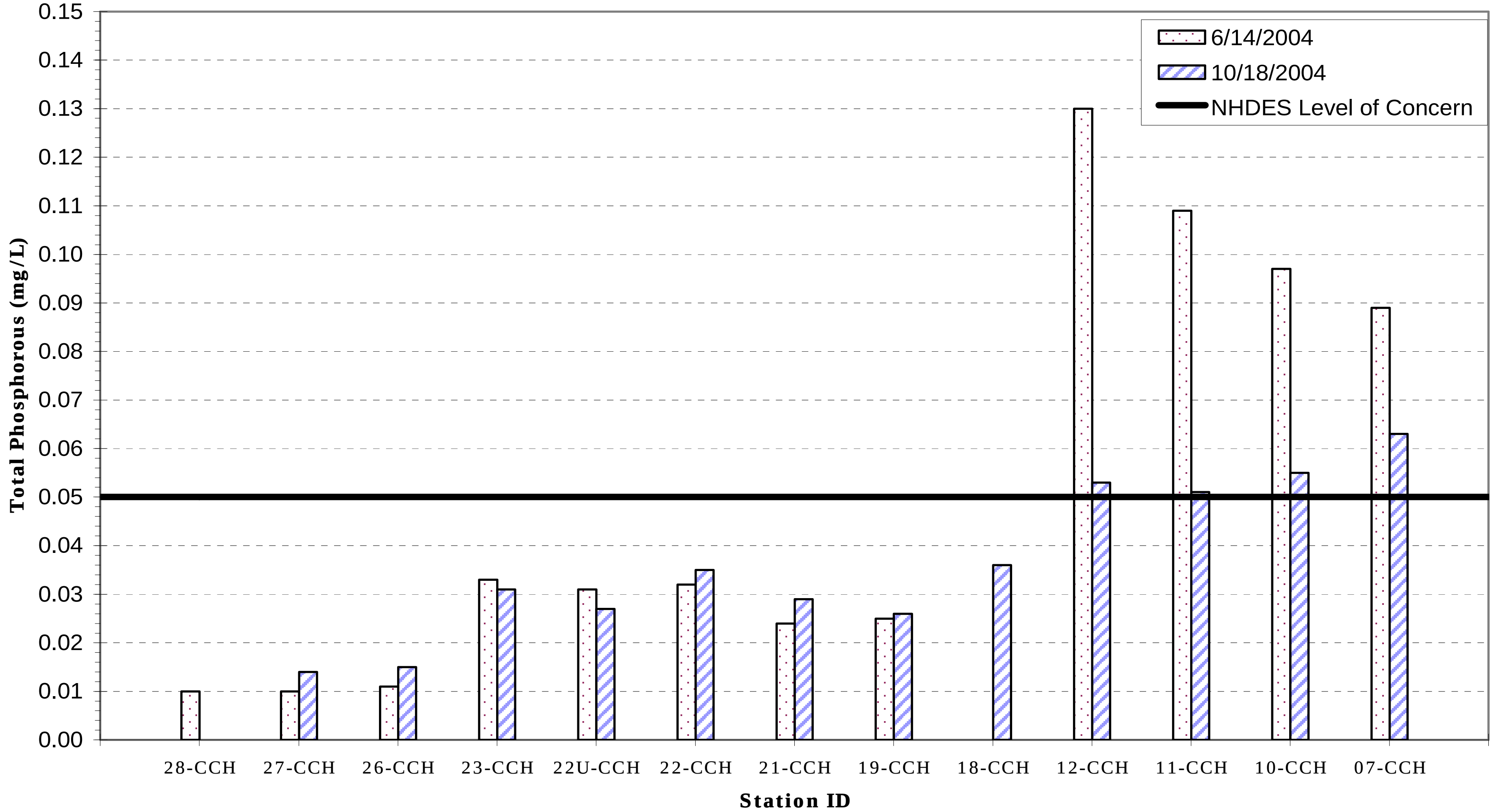
Total phosphorous levels were variable but, in general, levels increased from upstream stations to downstream stations. All measurements upstream of 12-CCH were below NHDES's level of concern. Total phosphorous levels at 12-CCH and the three stations further downstream always exceeded NHDES's level of concern. [Figure 5-6]. Under undisturbed natural conditions phosphorous is at very low levels in aquatic ecosystems. Of the three nutrients critical for aquatic plant growth; potassium, nitrogen, and phosphorous, it is usually phosphorous that is the limiting factor to plant growth. When the supply of phosphorous is increased due to human activity algae respond with significant growth.

A major source of excessive phosphorous concentrations in aquatic ecosystems can be wastewater treatment facilities, as sewage typically contains relatively high levels of phosphorus detergents. However, fertilizers used on lawns and agricultural areas can also contribute significant amounts of phosphorus

5.6.2. Recommendations

- At stations with elevated total phosphorous levels, begin sampling for chlorophyll-a. As mentioned above, high concentrations of phosphorous will lead to an increase in algal growth. Because algae is a plant and contains chlorophyll-a the concentration of chlorophyll-a found in the water will give an estimation of the concentration of algae. NHDES uses chlorophyll-a as an indicator in the assessment of surface water for primary contact recreation.
- Continue sampling total phosphorous at all stations as this will help to build a long-term data set to better understand trends as time goes on.

Figure 5-6. Total Phosphorous Statistics for the Cocheco River May 14 and October 18, 2004 NHDES VRAP



5.7. Iron

5.7.1. Results and Discussion

Two samples were collected for iron at 12 stations on the mainstem of the Cocheco River from Farmington to Dover (Table 5-8). All measurements met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2004 surface water quality report to the Environmental Protection Agency.

The Class B New Hampshire surface water quality standard for iron is as follows:

freshwater chronic criterion 1 mg/l
freshwater acute criterion no standard

Table 5-8 Iron Data Summary for the Cocheco River 2004, VRAP

Station ID	Samples Collected	Data Range (mg/L)	Acceptable Samples Exceeding NHDES Freshwater Chronic Criteria	Number of Usable Samples for 2006 NH Surface Water Quality Assessment
28-CCH	2	0.155 - 0.32	0	2
27-CCH	2	0.147 - 0.263	0	2
26-CCH	2	0.21 - 0.434	0	2
23-CCH	2	0.308 - 0.471	0	2
22U-CCH	2	0.875 - 1.45	1	2
22-CCH	2	0.595 - 0.965	0	2
21-CCH	2	0.693 - 1.04	1	2
19-CCH	2	0.674 - 1.03	1	2
12-CCH	2	0.455 - 0.745	0	2
11-CCH	2	0.531 - 0.884	0	2
10-CCH	2	0.494 - 0.817	0	2
07-CCH	2	0.531 - 0.857	0	2
Total Number of Useable Samples for 2006 NH Surface Water Quality Assessment				**24**

On one of the two sampling events, three of the ten stations sampled for iron exceeded the New Hampshire surface water quality chronic freshwater standard [Figure 5-7]. Iron is one the most abundant elements in the earth's crust. Rainfall and subsequent groundwater moving though soil and bedrock dissolve iron and carry it into surface waters.

Iron is not considered to be a health hazard but elevated levels can degrade the appearance and taste of drinking water supplies. Levels above 0.3 mg/L in drinking water can cause staining of laundry and household fixtures such as bathtubs and sinks can experience red or yellow staining.

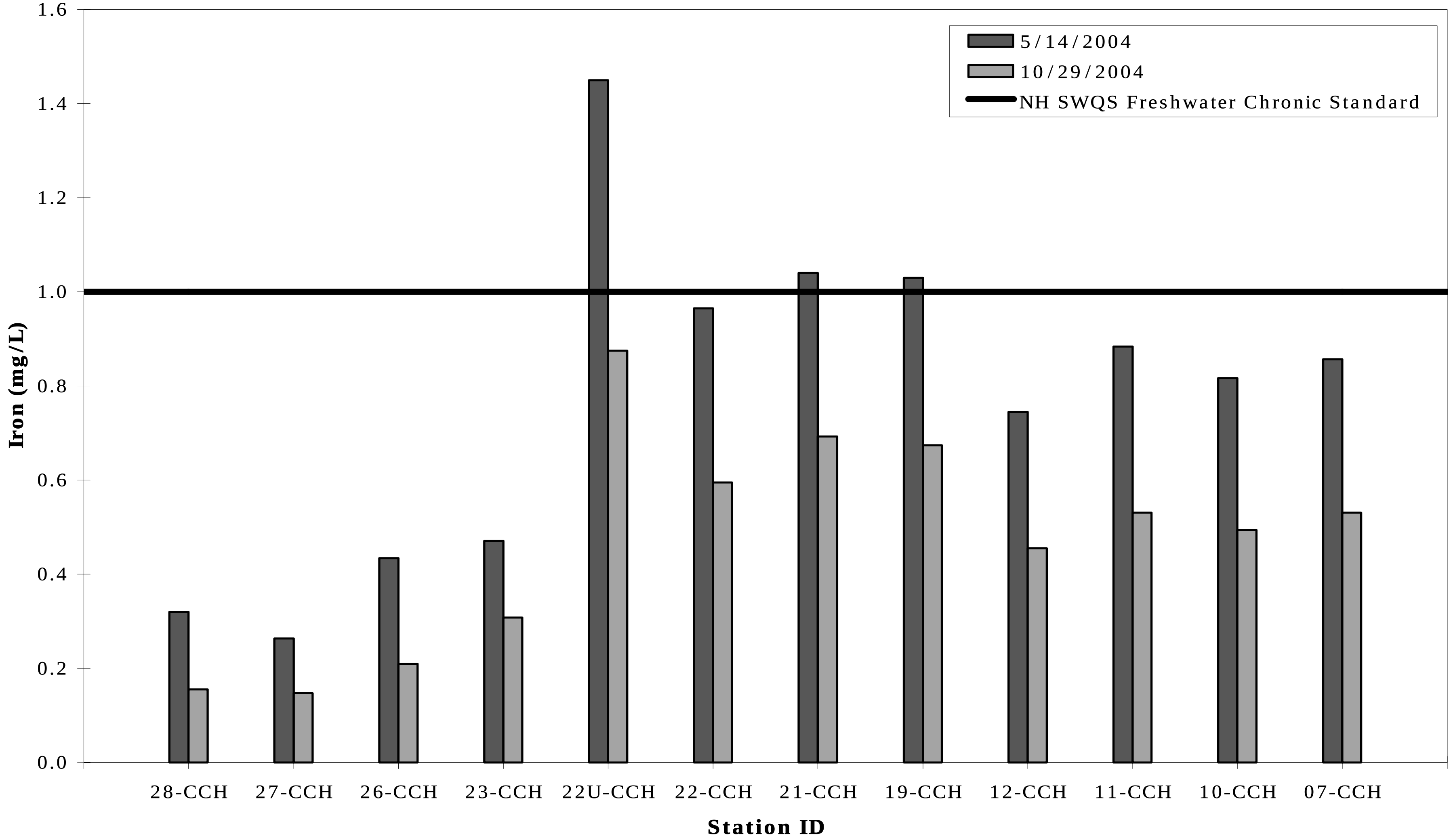
In general, well oxygenated water has low levels of iron because iron will react with oxygen to form compounds that do not stay dissolved in water. In surface waters, iron is likely to be trapped within suspended organic matter particles or in the sediment. Water that tends to have a low oxygen content such as groundwater often has elevated levels of dissolved iron due to the ability of the iron to remain in solution. Low oxygen conditions can also occur in shallow slow moving waters and thus facilitate higher dissolved iron levels.

Further investigation is necessary to determine whether the higher iron levels in the Cocheco River are due to the influence of groundwater, human activity, or both. The standard method used by the NHDES laboratory is for total iron thus including both dissolved iron and iron trapped in suspended particles.

5.7.2. Recommendations

- Additional sampling should be conducted to determine if there is a chronic iron problem in those segments that were above the standard this season. Additional sampling locations may be added to more accurately determine the source of the elevated iron levels.

Figure 5-7. Iron Statistics for the Cocheco River May 14 and October 29, 2004 NHDES VRAP



5.8. Arsenic

5.8.1. Results and Discussion

One sample was collected for arsenic at 12 stations on the mainstem of the Cocheco River from Farmington to Dover (Table 5-9). All measurements met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2004 surface water quality report to the Environmental Protection Agency.

The Class B New Hampshire surface water quality standard for arsenic is as follows:

freshwater chronic criterion <0.15 mg/l
freshwater acute criterion <0.34 mg/l

Table 5-9 Arsenic Data Summary for the Cocheco River 2004, VRAP

Station ID	Samples Collected	Data Range (mg/L)	Acceptable Samples Exceeding NHDES Freshwater Acute Criteria	Number of Usable Samples for 2006 NH Surface Water Quality Assessment
28-CCH	1	0.001	0	1
27-CCH	1	<0.0010	0	1
26-CCH	1	<0.0010	0	1
23-CCH	1	<0.0010	0	1
22U-CCH	1	0.0027	0	1
22-CCH	1	0.0018	0	1
21-CCH	1	0.0015	0	1
19-CCH	1	0.0015	0	1
12-CCH	1	0.0016	0	1
11-CCH	1	0.0019	0	1
10-CCH	1	0.0017	0	1
07-CCH	1	0.0018	0	1
Total Number of Useable Samples for 2006 NH Surface Water Quality Assessment				**12**

Arsenic concentrations were well below the chronic and acute Class B surface water quality standard at all stations sampled. Concentrations were also consistent from the upper to lower reaches of the river. Arsenic is naturally present in New Hampshire's soils and bedrock and arsenic concentrations are generally highest in groundwater. Southeastern New Hampshire has been identified as having elevated arsenic levels from ground water sources due to the geology of the region. Arsenic can however also be elevated in surface waters due to the burning of fossil fuels, smelting operations, and air emissions from manufacturing facilities.

5.8.2. Recommendations

- On no occasion were arsenic levels elevated and on most occasions the levels were just above the level detectable by the NHDES laboratory. Continued annual testing does not appear to be necessary but it may be useful to sample every 3 to 5 years to verify that levels are not increasing.

5.9. Chloride

5.9.1. Results and Discussion

One sample was collected for chloride at 12 stations on the mainstem of the Cocheco River from Farmington to Dover (Table 5-10). All measurements met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2004 surface water quality report to the Environmental Protection Agency.

The Class B New Hampshire surface water quality standard for chloride is as follows:

freshwater chronic criterion 230 mg/l
freshwater acute criterion 860 mg/l

Table 5-10 Chloride Data Summary for the Cocheco River 2004, VRAP

Station ID	Samples Collected	Data Range (mg/L)	Acceptable Samples Exceeding NHDES Freshwater Acute Criteria	Number of Usable Samples for 2006 NH Surface Water Quality Assessment
28-CCH	1	9	0	1
27-CCH	1	9	0	1
26-CCH	1	18	0	1
23-CCH	1	23	0	1
22U-CCH	1	28	0	1
22-CCH	1	26	0	1
21-CCH	1	30	0	1
19-CCH	1	34	0	1
12-CCH	1	25	0	1
11-CCH	1	25	0	1
10-CCH	1	26	0	1
07-CCH	1	26	0	1
Total Number of Useable Samples for 2006 NH Surface Water Quality Assessment				**12**

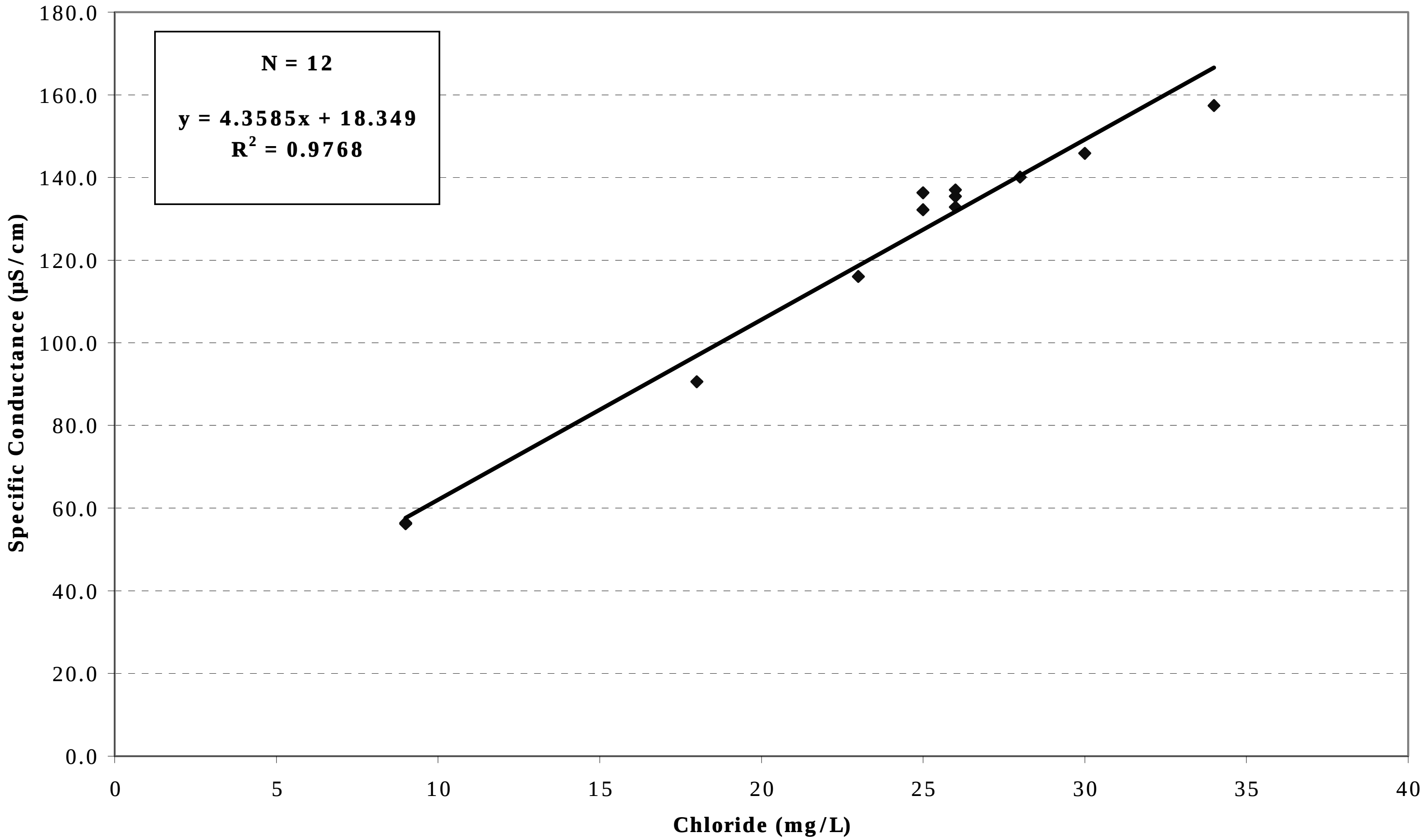
Chloride concentrations were well below the chronic and acute Class B surface water quality standard at all stations sampled. The primary source of high chloride levels in New Hampshire is halite (salt) applied to roadways. Additional human sources can come from fertilizers, septic systems, and underground water softening systems.

The NHDES has done research into the correlation between chloride levels in surface water and specific conductance levels. At the request of NHDES, the Cocheco River Watershed Coalition took specific conductance measurements at the same time chloride samples were collected. Figure 5-8 depicts a regression model between chloride concentrations and specific conductance levels from the data collected on June 14, 2004. Although the dataset only comprised 12 samples, the regression model shows a very close relationship between chloride levels and specific conductance levels (R^2 value = 0.98). This would indicate that higher chloride concentrations would be closely correlated with higher specific conductance levels. This correlation is consistent with additional studies being conducted by NHDES.

5.9.2. Recommendations

- Higher chloride levels are most likely to occur during periods of snowmelt. Additional sampling should be targeted to those periods when chloride levels are likely to be highest.
- Continue to take specific conductance measurements simultaneously with chloride samples.

Figure 5-8 Regression Correlation between Specific Conductance and Chloride in the Cocheco River 2004 VRAP



APPENDIX
2004 COCHECO RIVER WATER QUALITY DATA